

## APPENDIX E

### Sedimentation Assessment

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February 4, 2004

Mr. John Opie, First Selectman  
c/o Mr. Terry Elton  
Town of Branford  
1019 Main Street  
Branford, CT 06405

Reference: Islander East Pipeline Project - CT DEP Permit Application No. 200200761  
2003 Islander East Reply Brief

Dear First Selectman Opie

Please thank the Blue Ribbon Committee for forwarding to me portions of the December 22, 2003 Islander East Reply Brief. In response to representations made by Islander East regarding the sedimentation studies performed by me on behalf of the Town of Branford at the request of the Committee, I have prepared comments for the Committee's consideration.

It appears that Islander East, or at least the attorneys representing Islander East, conclude that my sedimentation studies support the conclusions drawn by Islander East. I would have to say that their conclusion is something of a stretch. As I have pointed out in the past, my sedimentation assessment concludes that the indirect impacts which result from the dredging operation will remain significant. The area of the seafloor to be removed by dredging includes approximately 0.75 Acres at the HDD exit hole and as much as 4.9 Acres from the footprint of the pipeline trench.

[ Note: Islander East has implied that this area may be reduced if the plasticity of the native soils is such that the trench side walls can be maintained at slopes steeper than 3:1. Islander East has not established that these steeper side walls can be maintained, simply that this may result. The State of Connecticut must consider the likely worst case scenario and assume the more conservative construction case.]

In any case, the direct impacts of this dredging will be as much as approximately 5.65 Acres. Islander East has provided no credible evidence, soils analysis, historic experience, or other scientifically based evidence that it will be less.

Indirect impacts will result from the deposition of sediments which are suspended during the dredging operations and transported into adjacent areas and deposited on the seafloor. The May 5, 2003 **Roberge Report** indicates that the indirect impacts of this deposition will extend a significant distance from the trench centerline. Those analyses demonstrated that the indirect impacts will be sensitive to the volume of material that is released at the point of dredging. Empirical values were used to demonstrate that as much as 1 mm of sediment could cover the seafloor to a distance of more than 100 meters from the trench centerline. Sediment thicknesses of up to 3 mm could be experienced as much as 40 meters from the trench centerline.

First Selectman John Opie  
Page 2

Islander East Brief Reply  
February 4, 2004

The area indirectly impacted by up to 3 mm of sediment cover could include more than 34.9 Acres. The area which could be covered by up to 1 mm of sediment includes more than 69.8 Acres. This area, potentially impacted by the proposed Islander East dredging operations, is significantly larger than that (14.0 Acres) claimed in their amended application. *The conclusion drawn in the attorney's brief does not appear to be accurate.*

Islander East further stated in their permit amendment documents, that they are currently consulting with federal and state agencies on whether to dispose of the dredged material offsite or return the material to the trench. The brief makes no note of this. The June 20, 2003 letter from Islander East to Ms. Susan Jacobson appears to clarify this uncertainty. It is currently understood that Islander East will seek authorization to relocate up to 30,000 cubic yards of dredged materials to the Central Long Island Disposal Site. This is significant.

As reported in the "Preliminary Report on the Anticipated Biological Impacts Associated with the proposed Islander East Pipeline Project, through the Nearshore Area of Long Island Sound - Branford, CT", prepared by The Garrett Group, LTD and dated May 8, 2003, near and far-field deposition of suspended solids may cause a measurable cover, or a thin veneer of fine particles cover over proximal hard bottom substrate. The Garrett report references benthic studies performed by the US Army Corps of Engineers (LaSalle et al 1991) which notes, contrary to Dr. Zajac's opinion, that sediment deposits of up to 1 mm will cause up to 50% mortality, and deposits of up to 2 mm will cause 100% mortality to some benthic species. Benthic species, e.g. Eastern Oyster, are so sensitive that thin sedimentation veneers can alter hard substrates ability to foul. With the presence of anoxic muds and silts, as will result from the deposition processes, anoxic episodes should be anticipated. In other words, benthic species will likely be killed even in areas receiving a thin veneer of deposited sediments.

The Haley and Aldrich "Report on Engineered Backfill Study", May 2003 demonstrates that the physico-chemical characteristics of the sediments to be dredged from the trench reach will likely allow the trench sidewalls to be excavated to slopes steeper than the originally planned 3:1. The letter of June 20, 2003 from Islander East to Ms. Susan Jacobson requests that the permit application be revised to allow dredging of up to 18,000 cubic yards from the pipeline trench (based upon an apparent 2:1 trench side slope), 6,000 cubic yards from the HDD exit area and an additional 6,000 cubic yards to accommodate contingency and facilitate construction. Islander East is apparently seeking authorization to dredge up to 30,000 cubic yards of bottom materials from those areas. Islander East further requests authorization to relocate the 30,000 cubic yards of dredged materials to the Central Long Island Sound Disposal Site. Again .. this volume is very significant in that it triggers specifically required testing of the sediments that does not appear to have been performed.

It is incumbent upon the State of Connecticut, Department of Environmental Protection, Office of Long Island Sound Programs (OLISP) and the US Army Corps of Engineers to assure that Islander East is in compliance with the Federal Marine Protection, Research and Sanctuaries Act (Ambro Amendment). It is essential that all required and currently valid mechanical, chemical, and biological characteristics of the dredged materials and the effect of their dredging and disposal be quantified prior to the issuance of any dredging authorization by the Federal and State regulatory and reviewing agencies.

ROBERGE ASSOCIATES COASTAL ENGINEERS, LLC

First Selectman John Opie  
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Islander East Brief Reply  
February 4, 2004

Islander East has amended the permit application to include backfilling of the dredged trench with engineered fill. The engineered fill is described in the Halcy and Aldrich report and will be a gravelly coarse to fine sand, further described as "bank-run gravel". The gradation demonstrated that the proposed material will include gravel as large as 2 in diameter. This material will fill the excavated trench to its total dredged width, which could be as much as 28 feet if the slopes can be held to 2:1 or even 37 feet if the slope sloughs to 3:1. This backfill material will effectively change the existing bottom type from a soft marine mud to a hardened gravel and sand over the entire  $37 \pm$  foot width and 5,800 foot length. This modification will significantly alter the existing benthic communities within the construction footprint. More significantly, this coarse backfill may completely change the fisheries within the trench band and could require commercial fishing operations to either abandon the area for soft bottom fishing methodologies or employ revised hard bottom methods. The proposed backfill will significantly impact the current fisheries operations.

It is our pleasure to have the opportunity to comment on the Islander East Reply Brief. Islander East has attempted, in the past, to address serious concerns which have been raised concerning their proposed construction operations. Islander East has not mitigated the critical sedimentation issues which will result from the dredging activities. The adjacent seafloor, over an area too potentially include as much as 69.8 Acres will be covered by sediments originating from the dredge operation. This seafloor burial has the potential to result in significant mortality within the benthic communities.

Very truly yours,

ROBERGE ASSOCIATES COASTAL ENGINEERS, LLC



John C. Roberge, P.E.  
Principal

c: Ms. Susan Jacobson, CT DEP (OLISP)

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September 30, 2003

Mr. Anthony J. DaRos  
First Selectman  
Town of Branford  
1019 Main Street  
Branford, CT 06405

Reference: Islander East Pipeline Project  
Amendment to CT DEP Permit Application No. 200200761

Dear Mr. DaRos

JOHN C. ROBERGE, P.E., LLC is pleased to provide the following comments regarding the amendment offered by the Islander East Pipeline Company to their Structures, Dredging and Fill Permit Application No. 200200761. The following documents were reviewed and form the basis for the commentary:

Islander East Pipeline Project - Amendment to the Structures, Dredging and Fill Permit Application - Construction Installation Modifications - Permit #200200761, March 14, 2003;

Report on Engineered Backfill Study, Islander East Natural Gas Pipeline, Branford, Connecticut - Prepared by Haley & Aldrich, Inc. for Project Consulting Services, Inc., May 2003;

Letter of June 20, 2003 from Gene Muhlherr, Islander East Pipeline Company, LLC to Ms. Susan Jacobson (OLISP); and

Letter of September 18, 2003 from Joseph C. Reinemann, Islander East Pipeline Company, LLC to Ms. Cori Rose (US Army Corps of Engineers).

**PROPOSED AMENDMENTS TO CONSTRUCTION METHODS**

The proposed amendment identifies two (2) general modifications to the original application. These modifications to the originally proposed construction techniques include:

- (1) The materials to be dredged from the HDD exit hole and the pipeline trench between MP 10.9 and 12.0 will be placed on barges, eliminating the original proposal to place the dredged materials on the adjacent seafloor;
- (2) Anticipated anchoring operations have been reduced as a result of the need for fewer plow passes to install the pipeline in 20' depths.

The following commentary addresses continued concerns regarding the proposed dredging operations and dredged material management in the HDD exit hole and between MP 10.9 and 12.0. As such, we have addressed only the issues associated with the dredging operations and do not provide commentary on the outstanding anchoring related impacts.

**Town of Branford      Comments Regarding Amendment to Permit Application #200200761**  
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**CRITICAL COMMENTARY**

The following paragraphs identify the various issues associated with the permit amendment(s) proposed by Islander East Pipeline Company in separate sections. Each section characterizes the amendment and offers comment regarding the relative merit of the amendment.

**Elimination of Spoil Mounds**

The proposal by Islander East to place the materials dredged from the HDD exit hole and from the trench between MP 10.9 and MP 12.0 into barges takes a significant step towards minimizing the direct impacts which would have resulted from the original scheme to place those materials on the seafloor adjacent to the trench. Islander East claims that this revision to their methodology will reduce both the direct and indirect impacts in the vicinity of the HDD exit hole from 23.8 Acres to 8.4 Acres and reduce the direct and indirect impacts in the vicinity of the dredged trench from 115 Acres to 5.6 Acres. Islander East attributes this claimed reduction to the elimination of the "spoil mounds" and the elimination of secondary impacts which would have resulted from the erosion of those mounds and subsequent sedimentation within adjacent resource areas.

While the direct impacts will likely be reduced, the indirect impacts which result from the dredging operation will remain significant. The area of the seafloor to be removed by dredging includes approximately 0.75 Acres at the HDD exit hole and as much as 4.9 Acres from the footprint of the pipeline trench. [ Note: Islander East has implied that this area may be reduced if the plasticity of the native soils is such that the trench side walls can be maintained at slopes steeper than 3:1. Islander East has not established that these steeper side walls can be maintained, simply that this may result. The State of Connecticut must consider the likely worst case scenario and assume the more conservative construction case.] In any case, the direct impacts of this dredging will be as much as approximately 5.65 Acres. The indirect impacts will result from the deposition of sediments which are suspended during the dredging operations and transported into adjacent areas and deposited on the seafloor. The May 5, 2003 report, prepared by JOHN C. ROBERGE, P.E., LLC for the Town of Branford indicates that the indirect impacts of this deposition will extend a significant distance from the trench centerline. Those analyses demonstrated that the indirect impacts will be sensitive to the volume of material that is released at the point of dredging. Empirical values were used to demonstrate that as much as 1 mm of sediment could cover the seafloor to a distance of more than 100 meters from the trench centerline. Sediment thicknesses of up to 3 mm could be experienced as much as 40 meters from the trench centerline. The area indirectly impacted by up to 3 mm of sediment cover could include more than 34.9 Acres. The area which could be covered by up to 1 mm of sediment includes more than 69.8 Acres. This area, potentially impacted by the proposed Islander East dredging operations, is significantly larger than that (14.0 Acres) claimed in their amended application.

**Benthic Impacts**

Islander East Pipeline Company has relied on the opinion of Dr. Roman Zajac, an independent marine biologist, to assess the potential effects of the anticipated sedimentation on benthic resources. Dr. Zajac notes that the elimination of the proposed sediment mounds will reduce the overall area of direct impact. Islander East claims that areas adjacent to the trench will be covered by less than 1 mm of sediment and that no mortality would be expected with these levels of deposition. The May 5, 2003 report by JOHN C. ROBERGE, P.E., LLC demonstrated that a significant area adjacent to the trench, as much as 69.8 Acres, could be covered by up to 1 mm of sediment resulting from the dredging operation. In fact, up to 34.9 Acres of seafloor could be covered by 3 mm or more of sediment released into the tidal waters during the trench dredging operations.

**Town of Branford      Comments Regarding Amendment to Permit Application #200200761**  
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While the direct impacts will likely be reduced, the indirect impacts which result from the dredging operation will remain significant. The area of the seafloor to be removed by dredging includes approximately 0.75 Acres at the HDD exit hole and as much as 4.9 Acres from the footprint of the pipeline trench. [ Note: Islander East has implied that this area may be reduced if the plasticity of the native soils is such that the trench side walls can be maintained at slopes steeper than 3:1. Islander East has not established that these steeper side walls can be maintained, simply that this may result. The State of Connecticut must consider the likely worst case scenario and assume the more conservative construction case.] In any case, the direct impacts of this dredging will be as much as approximately 5.65 Acres. The indirect impacts will result from the deposition of sediments which are suspended during the dredging operations and transported into adjacent areas and deposited on the seafloor. The May 5, 2003 report, prepared by JOHN C. ROBERGE, P.E., LLC for the Town of Branford indicates that the indirect impacts of this deposition will extend a significant distance from the trench centerline. Those analyses demonstrated that the indirect impacts will be sensitive to the volume of material that is released at the point of dredging. Empirical values were used to demonstrate that as much as 1 mm of sediment could cover the seafloor to a distance of more than 100 meters from the trench centerline. Sediment thicknesses of up to 3 mm could be experienced as much as 40 meters from the trench centerline. The area indirectly impacted by up to 3 mm of sediment cover could include more than 34.9 Acres. The area which could be covered by up to 1 mm of sediment includes more than 69.8 Acres. This area, potentially impacted by the proposed Islander East dredging operations, is significantly larger than that (14.0 Acres) claimed in their amended application.

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**Town of Branford      Comments Regarding Amendment to Permit Application #200200761**  
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Islander East further states in the amendment documents, that they are currently consulting with federal and state agencies on whether to dispose of the dredged material offsite or return the material to the trench. The June 20, 2003 letter from Islander East to Ms. Susan Jacobson appears to clarify this uncertainty. It is currently understood that Islander East will seek authorization to relocate up to 30,000 cubic yards of dredged materials to the Central Long Island Disposal Site.

As reported in the "Preliminary Report on the Anticipated Biological Impacts Associated with the proposed Islander East Pipeline Project, through the Nearshore Area of Long Island Sound - Branford, CT", prepared by The Garrett Group, LTD and dated May 8, 2003, near and far-field deposition of suspended solids may cause a measurable cover, or a thin veneer of fine particles cover over proximal hard bottom substrate. The Garrett report references benthic studies performed by the US Army Corps of Engineers (LaSalle et al 1991) which notes, contrary to Dr. Zajac's opinion, that sediment deposits of up to 1 mm will cause up to 50% mortality, and deposits of up to 2 mm will cause 100% mortality to some benthic species. Benthic species, e.g. Eastern Oyster, are so sensitive that thin sedimentation veneers can alter hard substrates ability to foul. With the presence of anoxic muds and silts, as will result from the deposition processes, anoxic episodes should be anticipated. In other words, benthic species will likely be killed even in areas receiving a thin veneer of deposited sediments.

**Trench Geometry and Dredging Volume**

The Haley and Aldrich "Report on Engineered Backfill Study", May 2003 demonstrates that the physico-chemical characteristics of the sediments to be dredged from the trench reach will likely allow the trench sidewalls to be excavated to slopes steeper than the originally planned 3:1. The letter of June 20, 2003 from Islander East to Ms. Susan Jacobson requests that the permit application be revised to allow dredging of up to 18,000 cubic yards from the pipeline trench (based upon an apparent 2:1 trench side slope), 6,000 cubic yards from the HDD exit area and an additional 6,000 cubic yards to accommodate contingency and facilitate construction. Islander East is apparently seeking authorization to dredge up to 30,000 cubic yards of bottom materials from those areas. Islander East further requests authorization to relocate the 30,000 cubic yards of dredged materials to the Central Long Island Sound Disposal Site.

It is incumbent upon the State of Connecticut, Department of Environmental Protection, Office of Long Island Sound Programs (OLISP) and the US Army Corps of Engineers to assure that Islander East is in compliance with the Federal Marine Protection, Research and Sanctuaries Act (Ambro Amendment). It is essential that all required and currently valid mechanical, chemical, and biological characteristics of the dredged materials and the effect of their dredging and disposal be quantified prior to the issuance of any dredging authorization by the Federal and State regulatory and reviewing agencies.

**Trench Cover**

Islander East has amended the permit application to include backfilling of the dredged trench with engineered fill. The engineered fill is described in the Haley and Aldrich report and will be a gravelly coarse to fine sand, further described as "bank-run gravel". The gradation demonstrated that the proposed material will include gravel as large as 2 in diameter. This material will fill the excavated trench to its total dredged width, which could be as much as 28 feet if the slopes can be held to 2:1 or even 37 feet if the slope sloughs to 3:1. This backfill material will effectively change the existing bottom type from a soft marine mud to a hardened gravel and sand over the entire 37 ± foot width and 5,800 foot length. This modification will significantly alter the existing benthic communities within the construction footprint. More significantly, this coarse backfill may completely change the fisheries within the trench band and could require commercial fishing operations to either

**Town of Branford      Comments Regarding Amendment to Permit Application #200200761**  
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abandon the area for soft bottom fishing methodologies or employ revised hard bottom methods. The proposed backfill will significantly impact the current fisheries operations.

**Summary**

It is our pleasure to have the opportunity to comment on the proposed permit amendments. Islander East has attempted to address serious concerns which have been raised concerning their proposed construction operations. Eliminating the sediment storage mounds most certainly is a positive step towards mitigating the dredging concerns. However, Islander East has not mitigated the critical sedimentation issues which will result from the dredging activities. The adjacent seafloor over an area as much as 69.8 Acres will be covered by sediments originating from the dredge bucket. This seafloor burial has the potential to result in significant mortality within the benthic communities.

Very truly yours,

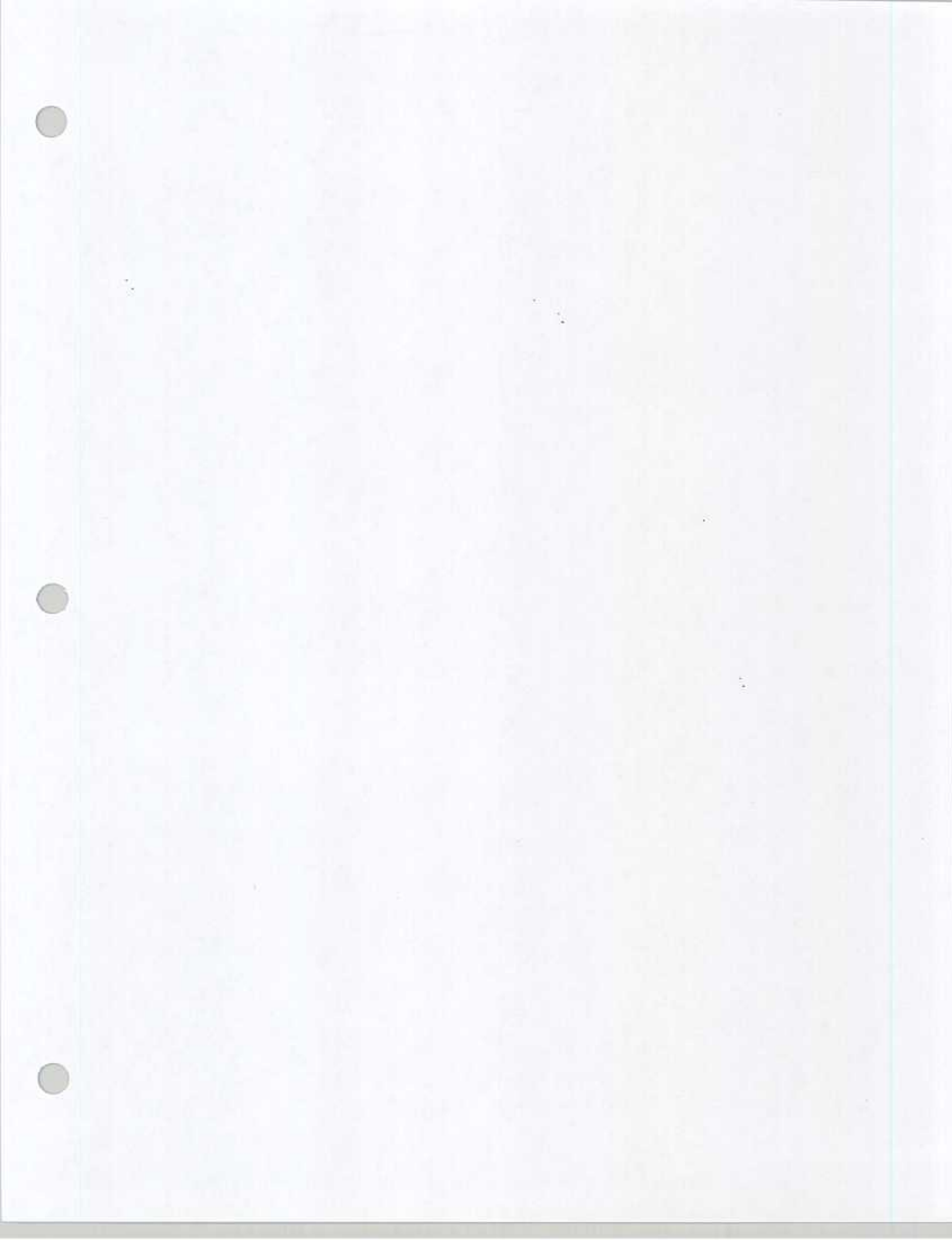
**JOHN C. ROBERGE, P.E., LLC**

A handwritten signature in black ink, appearing to read 'John C. Roberge', with a long horizontal flourish extending to the right.

John C. Roberge, P.E.  
Principal

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JOHN C. ROBERGE, P.E., LLC



# REPORT OF FINDINGS

**TOWN OF BRANFORD, CT**  
Long Island Sound

## **POTENTIAL SEDIMENTATION IMPACTS WHICH COULD RESULT FROM DREDGING**

**MP 10.9 - MP 12.0**  
**Proposed Construction of**  
**The Islander East Gas Transmission**  
**Pipeline**

**Prepared For**  
**The Town of Branford**

**Revision Date: May 5, 2003**

**Prepared By**



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**COASTAL ENGINEERING**  
*Foot of Broad Street, Stratford, CT 06615*  
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**TOWN OF BRANFORD,  
Long Island Sound**

**POTENTIAL SEDIMENTATION IMPACTS WHICH  
COULD RESULT FROM DREDGING**

**MP 10.9 - MP 12.0  
Proposed Construction of  
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**Prepared For  
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## EXECUTIVE SUMMARY

Potential sedimentation impacts which could result from construction dredging, proposed for the installation of the Islander East Gas Transmission Pipeline were evaluated by JOHN C. ROBERGE, P.E., LLC at the request of the Town of Branford. The proposed construction operations include dredging of approximately 51,000 cy of bottom sediments to construct a basin and pipeline trench. The project proponent originally planned to place the dredged material onto subaqueous mounds adjacent to the pipeline trench. The dredged material management methods have been altered, as reflected in documentation provided by the project proponent modifying the regulatory permit applications, to include placement of the dredged materials onto barges.

*It was demonstrated that turbidity levels and sediment deposition, resulting from the proposed construction of the Islander East Pipeline Company, LLC natural gas pipeline, will potentially and significantly impact the adjacent waters of Long Island Sound.*

The anticipated turbidity levels and deposition will be highly dependent upon the rate of initial sediment release at the dredging position. Empirical values of sediment release rates for comparable observed dredging operations were employed to develop limits of potential suspended sediment plumes which could result from the pipeline construction operations in the vicinity of MP 10.9 to MP 12.0. Suspended sediments could extend as far as 1000 meters from the centerline of the proposed pipeline trench and impact an area of as much as 1,700 Acres in the vicinity of the Thimble Islands in Long Island Sound. It is significant to note that the construction operations proposed by Islander East will involve, not just the initial construction dredging of the basin and trench, but will require the backfilling of the open trench to provide cover for the installed pipe. The impacts of the dredging will be effectively doubled. It was demonstrated that sediment deposits of up to 2.7 mm could result from the dredging operations in areas adjacent to the trench and that the backfilling operations could potentially double that accumulated mass.

The disposition of the dredged materials have not be completely described by the Islander East Pipeline Company, LLC. Alternatives include: placing of approximately 10,000 cy into the trench for protective cover of the installed pipeline; disposing of the remaining materials at the open water disposal sites in Long Island Sound; disposing of the remaining materials at yet undefined upland sites; covering the installed pipeline with engineered backfill; or a combination of each of these methods. It is anticipated that between 41,000 and 51,000 cy of the materials dredged from the HDD basin and pipeline trench could be disposed at the open water disposal facilities in Long Island Sound. It is essential that these materials be sufficiently characterized, including biological assessments, in accordance with the letter and intent of the Federal Marine Protection, Research and Sanctuaries Act.

**Construction of The Islander East Gas Transmission Pipeline  
Assessment of Sedimentation Impacts By proposed Dredging**

**Branford, CT  
May 5, 2003**

It is essential that the potential impacts upon pelagic, demersal and benthic fauna as well as subtidal flora imposed by the sedimentation processes be evaluated and quantified. Mitigation measures and operational constraints should be considered by regulatory authorities to minimize potential impacts. Similar dredging and construction operations have included a range of effective measures, including but not limited to:

Restricted temporal windows for operations to assure minimizing impacts upon potentially effected fauna and flora, including restriction of operations during the spawning periods of species indigenous to the project area;

Prohibition of stockpiling or sidecasting of dredged materials, requiring temporary storage of those materials on sealed floating barges;

Implementation of sealed dredge buckets to minimize re-entrainment and release of sediments into the water column during hauling operations;

Environmental sensitivity training for all dredge operators to assure knowledge of means and methods to minimize sediment release into the water column during dredging;

Imposing operational limits for sediment plume release size and concentration upon the dredging contractor and require termination of the dredging should those limits be exceeded;

Requiring "third-party oversight" of all operations and monitoring and assigning authorization to that entity to shut down the operations should operational limits be exceeded;

Requiring the dredging contractor to prepare and implement a *Construction Mitigation Plan*, clearly defining all of the means and methods which he proposes to employ to minimize construction impacts.

Imposing strict *Best Management Practices* upon the trench backfilling operations by requiring sediment plume size to be limited, imposing placement methodology restrictions, and related restrictions.

## 1.0 Potential Turbidity Plume and Sediment Deposition From Dredging Operations

### 1.1 Introduction

The 24" natural gas pipeline, proposed to be placed on the bottom of Long Island Sound and extend from Branford, CT to Wading River, NY, will include a dredged basin to accommodate the transition from the HDD operation and a 1.2 mile long pipeline trench to be excavated by traditional mechanical dredging operations (Islander East Pipeline Company, LLC, Ref 1). It was originally proposed by the project proponent that materials dredged from the transition basin and the pipeline trench would be placed on the ocean bottom in mounds adjacent to the dredged areas. Islander East Pipeline Company, LLC revised this proposed dredged material management method to that described in their "Amendment to the Structures, Dredging and Fill Permit Application - Construction Installation Modifications, (OLISP) Permit #200200761" and dated March 14, 2003 (Islander East Pipeline Company, LLC, Ref. 2). The modified method is to include placement of the dredged materials on barges. The proponent further notes that they propose to backfill the trench after placement of the pipeline to a depth such that 18" of cover are provided over the pipe. No further clarification of the methodology is provided in the permit modification document. It would appear that the ultimate fate of a significant volume of the material removed from the basin and trench, i.e. in fact approximately 78% of the material to be dredged, has not been identified. The proponent has noted that they are "consulting with federal agencies on whether to dispose of the dredged materials offsite and/or return the material to the trench". It can be assumed that Islander East Pipeline Company, LLC will seek further modification of the permit to relocate those dredged materials not used in backfilling the trench, amounting to approximately 40,000 CY, to the open water disposal sites in Long Island Sound and that all necessary, required and currently valid mechanical, chemical, and biological characteristics will be quantified prior to issuance of any dredging authorization by both Federal and State of Connecticut regulatory agencies.

It is anticipated that the HDD transition basin will be located near Mile Post 10.95. This basin is proposed to be approximately 250' in length and 130' in width with a maximum depth of 20'. The dredged pipeline trench will extend from the transition basin to Mile Post 12.0. Water depths in this area were readily available from NOAA navigation charts. The transition basin and dredged pipeline trench areas are characterized by a gently sloping bottom, with depths ranging from approximately 12' (MLW) in the area of the transition basin to about 22' (MLW) at the southern extent of the trench. Approximately 6,500 cy of sediment will be dredged from the basin and placed on the barges as currently proposed by Islander East Pipeline Company, LLC. As noted, the ultimate fate of about 78% of that volume has not been identified.

The pipeline trench will be dredged by mechanical bucket dredge. The trench will be dredged to a depth of approximately 8' below the natural bottom and anticipated side slopes of 3:1, creating a trapezoidal section. Approximately 44,680 cy of sediment will be removed from the trench and placed

onto barges as described above. After the 24" pipeline is placed into the trench, it is anticipated that a portion of the dredged materials will be used to backfill the trench and provide 18" of cover over the pipe. Islander East Pipeline Company, LLC has not identified the ultimate disposition or use of the materials remaining from the dredging operations. Neither the placement methodology nor the Best Management Practices (BMP's) to be employed by Islander East Pipeline Company, LLC during the backfilling operations have been identified. The effects of the potentially significant turbidity and material deposition within sensitive benthic communities which could result from the backfilling operations have not been quantified by Islander East.

## **1.2 Background**

Dredging operations at the transition basin and along the pipeline trench route have the potential to affect local sediment transport systems and/or the local ecosystems. Evaluation of each of these sites included an estimate of the worst-case suspended sediment plume which could result during the dredging procedures and an estimate of potential sediment deposition depths in areas adjacent to the trench and pipeline construction. The worst-case plume condition was approximated using empirical information, available for the site or available from representative historic dredging operations and reported in available literature.

The potential spatial impacts of the transition basin construction and the trenching operations included a quantitative estimate of the mass of sediment which could impact adjacent resources. Potential suspended sediment levels were quantified utilizing the steady governing equation for a dynamically passive suspended plume (Teeter, Ref. 3). As noted, this assessment will yield worst-case centerline concentrations, demonstrating maximum potential impacts of the plume on adjacent resources. The direction of plume propagation was assumed to be coincident with the direction of the predominant tidal currents at each site, as predicted by NOAA. The tidal current vectors used in this assessment vary from those employed by the Islander East Pipeline Company, LLC. That variation is discussed in this analysis.

## **1.3 Historical Experience**

Observations of pipeline trenching operations (Bohlen, Ref. 4) in Long Island Sound were made in 1991 to quantify potential sedimentation impacts upon adjacent oyster beds. The trenching operations included excavation of a trench, utilizing a large volume (13-22 CY) mechanical clamshell dredge, sidecasting the dredged materials along the adjacent margin of the trench, and backfilling of the trench from the margin after the pipeline was placed. The bottom materials at this site were primarily medium sands with occasional intrusions of coarse sands, gravel and mixtures of silt. The observation area was characterized by background concentrations of suspended materials which averaged between 5 and 10 mg/L. The Long Island Sound data indicated that suspended sediment concentrations within the turbidity plumes, associated with the pipeline installation procedures, decayed rapidly with distance downstream with the majority of sediment resuspended by the dredge settling within 30 -

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Assessment of Sedimentation Impacts Due to Proposed Dredging**

**Branford, CT  
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60 m of the operation. The field observations noted further that suspended sediment concentrations within the immediate vicinity of the dredge bucket ranged from 50 to 250 mg/L. These observations appear to be consistent with other dredging operations performed in both sand and fine grained materials (Bohlen, Ref. 5). Comparable values for a range of bottom material types are shown in Table 1. The observations further noted that the near-bottom suspended material field was essentially confined to a region extending between 450 m and 920 m downstream of the operating dredge.

**Table 1  
Historical Suspended Sediment Plume Characteristics  
For Dredging Operations**

Location	Water Depth (m)	Ave. Current Speed (cm/s)	Distance From Source (m)	Ave. Sediment Concentration (mg/L)
Hori River Nagoya, Japan	0.5	n/a	7	105
	1.5		7	70
	2.5		7	20
	0.5		13	-
Watertight Bucket (Ref. 6)	1.5		13	25
	2.5		13	13
	0.5		23	-
	1.5		23	-
(Note 1)	2.5		23	30
St. Johns River Jacksonville, FL (Ref. 7)	5.18	4.9	15	48
			30	214
			61	118
			122	50
			244	24
Black Rock Harbor Bridgeport, CT (Ref. 7)	6.1	6.7	30	281
			61	179
			122	95
			244	58
			488	77
Thames River New London, CT (Ref. 5)	11.0	15	33	86
			66	37
			100	22
			166	7
			233	5.5
			330	3.5

Note 1: Open bucket of similar size resulted in average sediment concentrations 1.56 times greater than closed bucket.

The dredging operations summarized on Table 1 were performed at sites with sediment characteristics comparable to the Islander East sites in the vicinity of the Thimble Islands in Branford, CT. The Hori River site included sediments which were predominantly clay and silt in water depths of approximately 3 m. The St Johns River operations were performed in silty sediments. Comparable bucket dredging operations in Black Rock Harbor and the Thames River included the dredging of primarily fine grained sands and silts. The plume generation associated with the Long Island Sound trenching work appeared to be confined to the dredge operational period with suspended sediment concentrations returning to pre-project levels almost immediately following cessation of the trenching operations. As noted (Bohlen, Ref. 4), this factor serves to reduce the time during which benthic or sessile organisms will be exposed to elevated suspended material concentrations.

It was further noted (Bohlen, Ref. 4), based upon the Long Island Sound trenching observations, that the discrete nature of the pipeline construction techniques suggested that it is appropriate to treat the operation as a moving point source of suspended materials. The source of suspended sediment will move progressively along the axis of the pipeline with resulting suspended materials distributed to either side of the pipeline under the alternating influence of local tidal currents.

#### 1.4 Assessment of Proposed Dredging Operations

To assess the potential spatial impacts of the Islander East dredging operations and to provide a quantitative estimate of the mass of sediment which could potentially impact adjacent resources, the dredging locations were evaluated utilizing the steady governing equation for a dynamically passive suspended plume (Teeter, Ref. 3). Simplifying the governing equation to a one-dimension expression, the solution for suspended sediment concentrations along the resulting plume centerline was expressed as:

$$C = [Q_s / (2HV_sX)] e^{-(PWX/HU)}$$

Where:

- C = Depth Averaged Suspended Sediment Concentration, mg/L
- $Q_s$  = Release Rate of Suspended Material at Source, g/s
- H = Depth, m
- U = Current Speed, cm/s
- $V_s$  = Horizontal Diffusion Velocity = 0.11(U)
- P = Depositional Probability
- W = Sediment Settling Velocity
- X = Distance From Source, m

The expression was simplified to  $C = [Q_s / (2HV_sX)]$  since the maximum value of the exponential term is unity. It is anticipated that this simplification will yield conservatively high or worst-case centerline concentrations, demonstrating maximum potential impacts of the plume on adjacent

resources. The direction of plume propagation was assumed to be coincident with the direction of the predominant tidal currents at each site. Solving the one-dimensional expression for various values of X, distance from the source, correcting that distance to determine the distance normal to the trench centerline, and tabulating the results generates a series of characteristic suspended sediment concentrations, C, for each location. The distance, d, normal from the centerline of the pipeline trench, was determined by the simple computation:

$$d_{\text{Flood}} = X_{\text{Flood}} \sin(a)_{\text{Flood}} \quad \text{or} \quad d_{\text{Ebb}} = X_{\text{Ebb}} \sin(a)_{\text{Ebb}}$$

Where:        d = Distance Normal From the Pipeline Axis  
               X = Modeled Distance From Source  
               a = Angle Between Tidal Current Direction and Pipeline Axis

The strength of the sediment source, R, is an empirical quantity. The value of the source strength, as generated by mechanical bucket dredge operations, has been observed (Collins, Ref. 7) to be dependent upon equipment geometry, operating characteristics such as speed and cycle time, depth of influence, and related characteristics.

Typical values of depth-averaged suspended sediment concentrations along the centerline of dredge buckets during water entry and withdrawal operations ranged between 50 - 500 mg/L. Typical values of initial sediment source release rates, as observed at several comparable operations, are summarized in Table 2. These values are typical of open bucket, and in several cases include closed-bucket, dredging operations and were used to quantify the range of potential impacts which could result from the Islander East dredging operations.

Table 2  
Open Bucket Resuspended Sediment Source Strengths (Ref. 7)

Site	Source Strength, R (g/s)	Observed Source Concentration, (mg/L)
Black Rock Harbor	1,684	520
Calumet River	243	75
St. Johns River Jacksonville, FL	445	250 (Open Bucket) 150 (Closed Bucket)
Lake City (Note 1)	n/a	55 (Open Bucket) 150 (Closed Bucket)

Note 1: Sidecasting operations

The limit of the zone of influence was chosen to be that distance at which the ambient velocity was equivalent to the critical velocity ( $V_{CRIT}$ ) required to maintain suspension of quartz sediments coarser than 200M (Vannoni, Ref. 8).  $V_{CRIT}$  for these sediments will be about 0.42 ft/s. The extent of the zone of influence, or the distance over which the initial sedimentation would take place will be approximately 55-ft or about 17-m. It was assumed that the released sediments at the dredging locations would be suspended over the entire water column due to the relatively shallow depths at these sites and that the coarse fractions would settle within 17m of either side of the trench. The characteristics of the Islander East dredging locations are summarized on Table 3. The general site characteristics include the site name, water depth, anticipated trenching technique, tidal current speeds, and average current directions referenced from the pipeline axis.

Plume generation and sedimentation potential at the dredging sites were simulated, based upon various initial sediment release rates. The sites are characterized by relatively typical sediment types. Each site includes observed fine lean clay and elastic silts, clays and traces of organics. The sediments were shown to display moderate plasticity. The average total unit weight of samples taken from the study areas, as reported by the project proponent, ranged from 89.6 to 94.9 pcf.

**Table 3**  
**Islander East Site Characteristics**

Characteristic	Site		
	MP 10.90	MP 11.5	MP 12.0
Trenching Method	Mechanical Dredging	Mechanical Dredging	Mechanical Dredging
Depth, m (MLW)	4.0	5.1	6.4
Peak Flood Current, cm/s	57.0	57.0	57.0
Direction of Flood Flow	265°	265°	265°
Peak Ebb Current, cm/s	72.0	72.0	72.0
Direction of Ebb Flow	82°	82°	82°

The results of the Islander East plume simulation, detailed on the computation sheets provided in Appendix A, are summarized in Table 4. These tabulated values represent the potential increase, above ambient conditions, which could be expected for suspended sediment concentrations resulting from the basin construction and trenching operations. It must be noted that the initial rate of sediment release and thus the sediment plume characteristics will be highly dependent upon the travel speed of the dredge bucket, skill of the operator, quality of the bucket and scow equipment, and related operational issues. Variation of the travel speed with depth, sediment types, wind and wave conditions, surface support efficiency and other unforeseen conditions should be anticipated.

**Table 4**  
**Islander East Pipeline Construction**  
**Potential Suspended Sediment Concentrations At Centerline of Turbidity Plume (mg/L)**

R=1,684 g/s

Station	Current Condition	Normal Distance From Trench Centerline, m (Note 1)							
		5	20	80	100	200	300	400	1000
MP 10.9	Flood	671	168	42	34	17	11	8	3
	Ebb	354	89	22	18	9	6	4	2
MP 11.5	Flood	527	132	33	26	13	9	7	3
	Ebb	299	75	19	15	7	5	4	1
MP 12.0	Flood	420	105	26	21	10	7	5	2
	Ebb	253	63	16	13	6	4	3	1

R=445 g/s

MP 10.9	Flood	177	44	11	9	4	3	2	1
	Ebb	94	23	6	5	3	2	1	0
MP 11.5	Flood	139	35	9	7	3	2	2	1
	Ebb	79	20	5	4	2	1	1	0
MP 12.0	Flood	111	28	7	6	3	2	1	1
	Ebb	67	17	4	3	2	1	1	0

R=243 g/s									
MP 10.9	Flood	97	24	6	5	2	2	1	0
	Ebb	51	13	3	3	1	1	1	1
MP 11.5	Flood	76	19	5	4	2	1	1	0
	Ebb	43	11	3	2	1	1	1	0
MP 12.0	Flood	61	15	4	3	2	1	1	0
	Ebb	37	9	2	2	1	1	0	0

Note 1: Does not include dredged materials relocated to the immediate vicinity of the trench.

The results of the suspended sediment plume analyses are graphically depicted on Figures 1 - 4, as provided in Appendix A of this report. Figure 1 depicts the approximate route of the proposed pipeline and position of the HDD transition basin. The project site is located west of the Thimble Islands in relatively shallow water. Figure 2 depicts the approximate spatial limits of the potential plume which would be formed by the dredging operations and assuming a sediment release rate of 1,684 g/sec.

The sediment release rate is an empirical value, determined from literature describing comparable dredging operations. Sediment is released from the dredging site through a combination of actions, including but not necessarily limited to: the dredge bucket impacting the ocean bottom; dragging of the bucket on the bottom; the shedding of sediments from the bucket as it is hauled through the water column; and related operational parameters. While an empirical sediment release rate of 1,684 g/sec is the highest observed at other sites, it must be assumed that such rates are likely to be realized at the Islander East site based upon their lack of identified Best Management Practices and commitment to operational controls.

For comparison, the analyses included development of potential suspended sediment plumes for lower observed sediment release rates. Figures 3 and 4 provide graphic representations of the extent of the likely plumes which would result from dredging operations with sediment release rates of 445 g/sec and 243 g/sec, respectively.

The quasi-steady tidal current vectors, employed in these analyzes, were based upon the observed tidal vectors as reported by the National Oceanic and Atmospheric Administration and universally reported in commonly used tide charts and related publications. These analyzes represent the maximum conditions that can be anticipated at the project site. Site specific tidal current observations, reported by the project proponent (Bohlen et. al, Ref. 9), indicated that maximum near-bottom tidal currents were approximately 45 cm/sec, with flooding currents typically exceeding ebb. Bohlen further notes a general net transport to the northwest resulting from the asymmetry of the tidal

current intensities. He notes that the nearshore reaches of the project site will be influenced by the islands and rocky outcrops and that net transport results from a dominance of the ebb currents in a generally northeast direction. He notes further that his observations clearly reflect the importance of wind induced velocities in these shallow water areas. The Bohlen report concludes "that the plume of sediments resuspended by the dredge will for the most part spread laterally to the east and west of the trench centerline due to the dominance of the east-west tending tidal currents."

The results of the analyses provided in tabular format and graphically depicted in Appendix A, clearly demonstrate the east-west tendency for plume dispersion. Magnitudes of turbidity concentration are dependent upon the magnitude of the tidal current velocity employed in these numerical simulations. Maximum tidal current velocities, representative of near-surface NOAA observations, were employed to generate potentially "worst-case" conditions which will result from the dredging operations. The time of dredging, position of the dredge, time in the tidal cycle, and related daily operational conditions can not specifically predicted and modeling all of the permutations and combinations of these performance criteria would be an overwhelming task. Consequently, demonstrating the "worst-case" operational scenario, by assuming maximum potential near-surface tidal currents and maximum sediment release rate represents a maximum potential impact to the surrounding benthic communities. No less than the maximum impact should be used to evaluate the impacts imposed by this proposed dredging operation.

It was estimated that a conservative approximation of deposited sediment thickness, resulting from the generated turbidity plume in the areas adjacent to the trench, could be developed by assuming that all of the materials suspended into the turbidity plume would be deposited at the maximum extent of transport. The deposition of sediment suspensions is analogous to marine gravity currents (Simpson, Ref.10). The mechanics of settlement at these sites, based upon the relatively high initial concentrations, will be dominated by the mass settlement of the suspension as opposed to gravimetric settlement of individual fine particles. The relatively fine characteristics of the sediment suspensions anticipated at these sites will result in visible plumes over a fairly broad expanse adjacent to the pipeline trench and as influenced by the local tidal currents.

Table 5 summarizes these estimated layer thickness as a function of distance, normal to the pipeline axis. This anticipated deposition will generally be a relatively thin veneer of typically mobile sediments. It is anticipated that the coarser fractions of the trench excavation will be placed immediately adjacent to the trench. These materials will be used to backfill the trench after the pipeline is placed. The anticipated thickness of deposition, as simulated in these analyzes, clearly demonstrate a direct relationship to suspended concentrations of sediments within the plume and to distance from the trenching operation. The orientation of the plume drift, represented in these analyzes by the relative direction of tidal currents to the axis of the pipeline, will significantly impact the location of the plume and thus the resulting deposition pattern.

Table 5  
Islander East Pipeline Construction  
Potential Deposited Sedimentation Layer Resulting From Turbidity Plume, cm

Sediment Release Rate From Dredge Bucket,  $R = 1,684 \text{ g/s}$

Station	Current Condition	Normal Distance From Trench Centerline, m							
		5	20	80	100	200	300	400	1000
MP 10.95	Flood	0.27	0.04	0.01	0.01	0.01	0.0	0.0	0.0
	Ebb	0.14	0.04	0.01	0.01	0.0	0.0	0.0	0.0
MP 11.5	Flood	0.25	0.04	0.01	0.01	0.01	0.0	0.0	0.0
	Ebb	0.14	0.04	0.01	0.01	0.0	0.0	0.0	0.0
MP 12.0	Flood	0.24	0.04	0.01	0.01	0.01	0.0	0.0	0.0
	Ebb	0.14	0.04	0.01	0.01	0.0	0.0	0.0	0.0

Sediment Release Rate From Dredge Bucket,  $R=445 \text{ g/s}$

MP 10.95	Flood	0.07	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0
MP 11.5	Flood	0.07	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0
MP 12.0	Flood	0.06	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0

Sediment Release Rate From Dredge Bucket,  $R=243 \text{ g/s}$

MP 10.95	Flood	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.02	0.01	0.0	0.0	0.0	0.0	0.0	0.0
MP 11.5	Flood	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.06	0.01	0.01	0.01	0.0	0.0	0.0	0.0
MP 12.0	Flood	0.03	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.02	0.01	0.0	0.0	0.0	0.0	0.0	0.0

## **1.5 Trench Backfilling**

The pipeline trench will be dredged by mechanical bucket dredge. The trench will be dredged to a depth of approximately 8' below the natural bottom and will include side slopes of 3:1, creating a trapezoidal section as shown in Figure 5 of this report. Approximately 51,180 cy of sediment will be removed from the HDD basin and pipeline trench and placed onto barges as described above. After the 24" pipeline is placed into the trench, it is anticipated that a portion of the dredged materials will be used to backfill the trench and provide 18" of cover over the pipe.

The backfilling operation will require the placement of approximately 10,000 cy of material to be dropped or transported through the water column over the basin and trench. The proponent has noted that they are "consulting with federal agencies on whether to dispose of the dredged materials offsite and/or return the material to the trench". It can be assumed that Islander East Pipeline Company, LLC will seek further modification of the permit to relocate those dredged materials not used in backfilling the trench, amounting to approximately 41,180 cy, to the open water disposal sites in Long Island Sound and that all necessary, required and currently valid mechanical, chemical, and biological characteristics will be quantified prior to issuance of any dredging authorization by both Federal and State of Connecticut regulatory agencies.

As depicted in Figure 5, approximately 22% of the material removed from the trench will be used for backfilling and pipeline cover. More than 41,000 cy of dredged materials will have to be disposed as a result of this proposed operation. Islander East Pipeline Company, LLC has not identified the ultimate disposition or use of the materials remaining from the dredging operations. The methodology or Best Management Practices (BMP's) to be employed by Islander East Pipeline Company, LLC during the backfilling operations have not been identified. The effects of the potentially significant turbidity and material deposition within sensitive benthic communities which could result from the backfilling operations have not been identified by Islander East.

It is reasonable to conclude that the basin and trench backfilling operations could result in elevated suspended sediment levels at least equivalent to those which have been demonstrated to characterize the dredging operations. The potential impacts of the dredging, as summarized in Tables 4 and 5 of this report, could be effectively doubled by the backfilling.

## **2.0 Dredged Material Management**

The original pipeline construction operations included the proposed sidecasting of the dredged sediments into mounds, placed along the perimeter of the transition basin and pipeline trench. These mounds were expected to extend between 10' and 11' above the natural bottom. The crests of these mounds would be positioned between 2' and 10' below the water surface during periods of low tide. It was evident that these mounds, in addition to presenting severe restrictions and significant hazards to local navigation, would be exposed to erosion processes imposed by wind generated waves which

characterize this site. Sediments placed into these mounds and suspended by waves, would enter the water column and be transported from the site by tidal currents and related mechanisms.

As a result of the obvious potential environmental impacts imposed upon the surrounding benthic resources, Islander East Pipeline Company, LLC revised this proposed dredged material management method to that described in their "Amendment to the Structures, Dredging and Fill Permit Application - Construction Installation Modifications, (OLISP) Permit #200200761" and dated March 14, 2003 (Islander East Pipeline Company, LLC, Ref. 2). The modified method is to include placement of the dredged materials on barges. The modified methodology notes that they propose to backfill the trench after placement of the pipeline to a depth 18" over the placed pipe. Figure 5 provides a graphic representation of the typical trench section. No further clarification of the methodology is provided in the permit modification document. The ultimate fate of a significant volume of the material removed from the basin and trench, i.e. in fact approximately 78% of the material to be dredged, has not been identified. The proponent has noted that they are "consulting with federal agencies on whether to dispose of the dredged materials offsite and/or return the material to the trench". It can be estimated that approximately 10,000 cy of the dredged materials will be used for backfilling of the trench. That material will have to be placed by mechanical dredge or dumped from the barges on which the material is proposed to be stored.

It can be assumed that Islander East Pipeline Company, LLC will seek further modification of the permit to relocate those dredged materials not used in backfilling the trench, amounting to more than 41,000 cy, to the open water disposal sites in Long Island Sound and that all necessary, required and currently valid mechanical, chemical, and biological characteristics will be quantified prior to issuance of any dredging authorization by both Federal and State of Connecticut regulatory agencies.

## **2.1 Background**

The processes involved in the resuspension and transport of bottom sediments in shallow marine environments are highly complex and difficult to describe because each of the key mechanisms involving water movement and water-sediment interaction are, in themselves, complex. Weggel (Ref. 11) notes that suspended sediments are generally smaller than materials transported near the bottom. Weggel concludes that, regardless of the mode of transport, several prerequisites for net sediment movement can be identified. These include: (1) a source of movable sediment must be available; (2) a mechanism for initiating sediment movement is required; and (3) an asymmetry in the sediment motion must be present. Each of these prerequisites is present at the Islander east site.

The dredged material mounds would have provided a ready source of movable sediment. While the bottom materials appear to show plastic characteristics associated with cohesive sediments, the materials would be significantly disturbed during dredging resulting in higher water content than found in the in-situ state, thus more readily movable. The shallow bathymetry along the entire dredging route can be significantly influenced by wind generated shallow water waves. These waves,

particularly those associated with storm events, would provide more than adequate energy to resuspend and lift the dredged sediments off the mounds. Once suspended by the generally symmetrical flow regime associated with passing waves, net transport of these sediments suspended from the mounds would be a function of the tidal currents which characterize the area.

The U.S. Army Corps of Engineers (Douglass, et al., Ref. 12) acknowledges the ability of currents and waves to resuspend and transport sediments which have been placed on the ocean bottom during underwater placement operations associated with dredging projects. The U.S. Army Corps of Engineers' studies involved the monitoring of several submerged mounds or berms of generally non-cohesive dredged materials placed on the bottom of Mobile Bay. It was noted that faster peak speed of water particles under wave crests appears to be the dominant mechanism which moved these submerged berms.

## **2.2 Assessment of Potential Sediment Mound Erosion**

It is clear that dredged material mounds, originally proposed to be placed adjacent to the transition basin and trench as a part of the Islander East pipeline construction work, could be subject to resuspension and transport via mechanisms which are typical of the site. The site is subject to storm events, most typically associated with hurricanes and nor'easter's which impact the region. These meteorological conditions typically generate wind waves originating over the open water fetches to the south and southwest of the Thimble Islands. Storm wave conditions, which can be expected at this site are summarized in Table 6. These wave characteristics were computed using the Sverdrup-Munk-Bretschneider (SMB) empirical approximation for shallow water waves as detailed on the computation sheets provided in Appendix B. The potential wave conditions were developed for a range of wind conditions which can be experienced over Long Island Sound. These conditions represent the 100-Year recurrence interval (1% chance of annual exceedence), the 50-Year recurrence interval (2% chance of annual exceedence), and the 2-Year recurrence interval (50% chance of annual exceedence).

**Table 6  
Characteristic Storm Wave Conditions Effecting the Project Site**

Recurrence Interval	Wind Speed (mph)	South Fetch			Southwest Fetch		
		Fetch Length (mi)	Wave Characteristics		Fetch Length (mi)	Wave Characteristics	
			H <sub>s</sub> (ft)	T (sec)		H <sub>s</sub> (ft)	T (sec)
100-Yr	100	20.4	20.0	8.0	54.0	24.5	10.0
50-Yr	90		17.8	7.6		22.0	9.6
2-Yr	50		9.4	6.0		12.9	7.5

These wave characteristics represent the deepwater conditions of the significant wave, i.e the average of the highest 1/3 of the waves that would be generated by the representative wind blowing over the indicated fetch distance for a duration sufficient to fully develop the wave set. The required duration for the tabulated waves ranged between 2.4 hours and 6 hours. The water depths at the project site range between approximately 10' and 20', referenced to local mean low water. Water surface elevations can vary with tidal stage and coastal flooding conditions throughout Long Island Sound, but the relatively shallow conditions along the entire trench route will likely lead to breaking wave conditions, thus introducing sediment transport mechanisms similar to those on a beach face.

**Table 7**  
**Wave Induced Near-Bottom Horizontal Velocities at Dredge Mound Locations, ft/s**

Recurrence Interval	Maximum Anticipated Bottom Velocities, ft/s		
	MP 10.9	MP 11.5	MP 12.0
100-Yr	12.3	13.8	13.9
50-Yr	12.3	13.7	12.3
2-Yr	9.2	7.9	6.8

Note 1: To convert ft/s to cm/s multiply ft/s by 30.48. Example - 6.8 ft/s x 30.48 = 207.3 cm/s or 2.07 m/s.

As noted from the literature citations, the primary mechanism for resuspending sediments from the proposed sediment mounds would be the movement of water induced by the passage of waves over the site. As waves translate past a position on the shallow ocean bottom, the water particles within the water column beneath the wave, will move in an orbital motion. Each water particle will assume a vertical and horizontal displacement. The size of the orbital motion and velocity of the vertical and horizontal water movement is dependent upon the wave height and period and upon the depth of water. Table 7 provides a summary of potential near-bottom wave orbital velocities which would be associated with the possible storm wave conditions at the project site.

Figure 6, provided in Appendix A, is a summary of empirical observations of sediment movement under wave action. This data clearly demonstrates that fine sediments, similar to those originally proposed to be placed in the mounds would likely be moved by water velocities exceeding 10 cm/sec. The potential near-bottom wave orbital velocities which can be realized at these sites during storms can be an order-of-magnitude greater than the threshold velocities for sediment motion. Disregarding the effects of waves breaking on the mounds, an evaluation of these near-bottom velocities revealed that the magnitude of these velocities would be sufficient to mobilize all of the materials that would have been placed in the sidecast mounds. The total volume of sediments which could be resuspended from the mounds would be dependent upon the duration of the wave impacts upon the site and upon the depth of the boundary motion at the water-sediment interface. However, the relatively significant

turbulence which will be associated with storm wave passage in combination with the high orbital velocities would dislodge and transport sediments from these sites.

Sediment particles would be resuspended and transported from the mound position with the passing of each wave. The maximum anticipated period of a storm generated surface wave at the construction sites was demonstrated to be 10 seconds. It can be estimated that horizontal velocities of sufficient magnitude to mobilize the sediments will occur over approximately one-half of the wave period. It is therefore reasonable to argue that conditions favorable for erosion of the sediment mounds could persist for at least one-half of the time that the storm waves influence the site. A storm of 6-hour duration could potentially erode the entire mound system and place those materials into suspension. The mobilized sediments would be transported into adjacent waters and sensitive benthic habitat.

### **2.3 Dredged Material Management Alternatives**

The modified construction methods, proposed by Islander East Pipeline Company, LLC, will require the disposition of more than 51,000 cy of materials removed from the HDD basin and pipeline trench. The five (5) general alternatives include:

Placement of the excavated sediments into the basin and trench to provide cover for the pipe and to restore the bottom to near pre-construction grade;

Placement of approximately 10,000 cy of the dredged sediments into the trench as cover for the pipeline and disposal of the remaining 41,000 cy of dredged materials at an upland disposal facility;

Placement of approximately 10,000 cy of the dredged sediments into the trench as cover for the pipeline and disposal of the remaining 41,000 cy of dredged materials at the Open Water Dredged Material Disposal sites in Long Island Sound;

Placement of approximately 10,000 cy of engineered backfill into the trench as cover for the pipeline and disposal of the 51,000 cy of dredged materials at an upland disposal facility; or

Placement of approximately 10,000 cy of engineered backfill into the trench as cover for the pipeline and disposal of the 51,000 cy of dredged materials at the Open Water Dredged Material Disposal sites in Long Island Sound.

As noted in previous sections of this report, placement of the dredged materials back into the basin and trench will expose the Thimble Island region to elevated turbidity levels and potential deposition of mobilized sediments onto sensitive benthic habitat areas. The magnitude of the impacts can be based upon the general results of the dredging impact assessment.

Open water disposal of dredged materials is regulated by both the U.S. Army Corps of Engineers and the State of Connecticut, Department of Environmental Protection, Office of Long Island Sound Programs (OLISP). Open water disposal of more than 25,000 cy of dredged materials requires compliance with the Federal Marine Protection, Research and Sanctuaries Act (Ambro amendment). It is essential that all reviewing agencies, including but not limited to the U.S. Environmental Protection Agency, U.S. Fish & Wildlife, and others, review the specific dredging and dredged material disposal plan proposed by Islander East Pipeline Company, LLC. It is essential that all required and currently valid mechanical, chemical, and biological characteristics of the dredged materials be quantified prior to issuance of any dredging authorization by the Federal and State of Connecticut regulatory agencies.

### **3.0 Summary and Conclusions**

It was demonstrated that turbidity levels and sediment deposition, resulting from the proposed construction of the Islander East Pipeline Company, LLC natural gas pipeline, will potentially and significantly impact the adjacent waters of Long Island Sound. The anticipated turbidity levels and deposition will be highly dependent upon the rate of initial sediment release at the dredging position. Empirical values of sediment release rates for comparable observed dredging operations were employed to develop limits of potential suspended sediment plumes which could result from the pipeline construction operations in the vicinity of MP 10.9 to MP 12.0. Suspended sediments could extend as far as 1000 meters from the centerline of the proposed pipeline trench and impact an area of as much as 1,700 Acres in the vicinity of the Thimble Islands in Long Island Sound. It is significant to note that the construction operations proposed by Islander East will involve, not just the initial construction dredging of the basin and trench, but will require the backfilling of the open trench to provide cover for the installed pipe. The impacts of the dredging quantified in the text will be effectively doubled. Sediments transported by local tidal flows away from the construction site will be deposited on the bottom areas adjacent to the trench.

The original proposed construction work included placing the materials dredged from the HDD transition basin and the pipeline trench into mounds adjacent to the areas of excavation. This construction methodology has been modified. Islander East Pipeline Company, LLC currently proposes to store those dredged materials on barges and either use them as cover over the installed pipeline or dispose of them in the open water disposal sites in Long Island Sound or at upland offsite facilities.

The disposition of the dredged materials have not be completely described by the Islander East Pipeline Company, LLC. It is anticipated that between 41,000 and 51,000 cy of the materials dredged from the HDD basin and pipeline trench could be disposed at the open water disposal facilities in Long Island Sound. It is essential that these materials be sufficiently characterized, including biological assessments, in accordance with the letter and intent of the Federal Marine Protection, Research and Sanctuaries Act.

It is essential that the potential impacts upon pelagic, demersal and benthic fauna as well as subtidal flora imposed by the sedimentation processes be evaluated and quantified. Mitigation measures and operational constraints should be considered by regulatory authorities to minimize potential impacts. Similar dredging and construction operations have included a range of effective measures, including but not limited to:

Restricted temporal windows for operations to assure minimizing impacts upon potentially effected fauna and flora, including restriction of operations during the spawning periods of species indigenous to the project area;

Prohibition of stockpiling or sidecasting of dredged materials, requiring temporary storage of those materials on sealed floating barges;

Implementation of sealed dredge buckets to minimize re-entrainment and release of sediments into the water column during hauling operations;

Environmental sensitivity training for all dredge operators to assure knowledge of means and methods to minimize sediment release into the water column during dredging;

Imposing operational limits for sediment plume release size and concentration upon the dredging contractor and require termination of the dredging should those limits be exceeded;

Requiring "third-party oversight" of all operations and monitoring and assigning authorization to that entity to shut down the operations should operational limits be exceeded;

Requiring the dredging contractor to prepare and implement a *Construction Mitigation Plan*, clearly defining all of the means and methods which he proposes to employ to minimize construction impacts.

Imposing strict *Best Management Practices* upon the trench backfilling operations by requiring sediment plume size to be limited, imposing placement methodology restrictions, and related restrictions.

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